

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No. 10/606,182

Attorney Docket No. Q76316

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

Claims 1-20. (canceled)

21. (previously presented): An ink jet recording head formed by a method comprising:

- forming a first electrode layer on a diaphragm;
- forming a piezoelectric layer on the first electrode layer;
- forming a second electrode layer on the piezoelectric layer; and
- etching completely through the second electrode layer, the piezoelectric layer, and the first electrode layer so that a portion of the diaphragm is exposed.

22. (previously presented): The ink jet recording head according to claim 21, wherein the diaphragm is attached to a substrate.

23. (previously presented): The ink jet recording head according to claim 22, wherein a nozzle plate is attached to the substrate.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No. 10/606,182

Attorney Docket No. Q76316

24. (previously presented): The ink jet recording head according to claim 23, wherein the nozzle plate is formed with a nozzle orifice.

25. (previously presented): A method of manufacturing an ink jet recording head, the method comprising:

forming a first electrode layer on a diaphragm;

forming a piezoelectric layer on the first electrode layer;

forming a second electrode layer on the piezoelectric layer; and

etching completely through the second electrode layer, the piezoelectric layer, and the first electrode layer so that a portion of the diaphragm is exposed.

26. (previously presented): The method according to claim 25, further comprising attaching the diaphragm to a substrate.

27. (previously presented): The method according to claim 26, further comprising attaching a nozzle plate to the substrate.

28. (previously presented): The method according to claim 27, forming a nozzle orifice in the nozzle plate.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No. 10/606,182

Attorney Docket No. Q76316

29. (previously presented): The method according to claim 25, wherein only a single mask material is used to pattern the second electrode layer, the piezoelectric layer, and the first electrode layer during the etching step.

30. (previously presented): An ink jet recording head formed by a method comprising:

forming a first electrode layer on a diaphragm;

forming a piezoelectric layer on the first electrode layer;

forming a second electrode layer on the piezoelectric layer; and

etching completely through at least the second electrode layer and the piezoelectric layer so that a portion of the diaphragm is exposed.

31. (previously presented): The ink jet recording head according to claim 30, wherein the diaphragm is attached to a substrate.

32. (previously presented): The ink jet recording head according to claim 31, wherein a nozzle plate is attached to the substrate.

33. (previously presented): The ink jet recording head according to claim 32, wherein the nozzle plate is formed with a nozzle orifice.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No. 10/606,182

Attorney Docket No. Q76316

34. (New) An ink jet recording head formed by a method comprising:
forming a first electrode layer on a diaphragm;
forming a piezoelectric layer on the first electrode layer;
forming a second electrode layer on the piezoelectric layer; and
etching completely through the second electrode layer and the piezoelectric layer so that
a portion of the first electrode layer is exposed.

35. (New) The ink jet recording head according to claim 34, wherein the diaphragm
is attached to a substrate.

36. (New) The ink jet recording head according to claim 35, wherein a nozzle plate is
attached to the substrate.

37. (New) The ink jet recording head according to claim 36, wherein the nozzle plate
is formed with a nozzle orifice.

38. (New) A method of manufacturing an ink jet recording head, the method
comprising:

forming a first electrode layer on a diaphragm;
forming a piezoelectric layer on the first electrode layer;
forming a second electrode layer on the piezoelectric layer; and

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No. 10/606,182

Attorney Docket No. Q76316

etching completely through the second electrode layer and the piezoelectric layer so that a portion of the first electrode layer is exposed.

39. (New) The method according to claim 38, further comprising attaching the diaphragm to a substrate.

40. (New) The method according to claim 39, further comprising attaching a nozzle plate to the substrate.

41. (New) The method according to claim 40, forming a nozzle orifice in the nozzle plate.

42. (New) The method according to claim 38, wherein only a single mask material is used to pattern the second electrode layer, the piezoelectric layer, and the first electrode layer during the etching step.

43. (new): An ink jet recording head comprising:
a substrate including at least a head base and a nozzle plate;
an ink chamber formed in said head base;
a nozzle formed in said nozzle plate, said nozzle communicating with said ink chamber;
a diaphragm provided on said head base for pressurizing ink in said ink chamber, said diaphragm including a common electrode;

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No. 10/606,182

Attorney Docket No. Q76316

a piezoelectric thin film provided on said diaphragm; and
a separate electrode provided on said piezoelectric thin film for applying an electric field to said piezoelectric thin film,
wherein said piezoelectric thin film and said separate electrode are patterned such that (1) said piezoelectric thin film is patterned to be a discrete piezoelectric thin film, (2) a pattern shift between said discrete piezoelectric thin film and said separate electrode is eliminated, (3) said discrete piezoelectric thin film does not extend in a lateral direction beyond lateral side surfaces of said separate electrode, and (4) said common electrode extends in the lateral direction beyond lateral side surfaces of said discrete piezoelectric thin film.

44. (new): The ink jet recording head according to claim 43, wherein a plurality of discrete piezoelectric thin films is provided on said diaphragm, and a plurality of separate electrodes is respectively provided on said discrete piezoelectric thin films.

45. (new): The ink jet recording head according to claim 43, wherein said discrete piezoelectric thin film is 0.3-5 μm thick.

46. (new): The ink jet recording head according to claim 43, wherein said discrete piezoelectric thin film superposes over said ink chamber without extending in the lateral direction beyond said ink chamber, and

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No. 10/606,182

Attorney Docket No. Q76316

wherein a portion of said diaphragm that is not attached to said discrete piezoelectric thin film is thinner than a portion of said diaphragm that is attached to said discrete piezoelectric thin film.

47. (new): The ink jet recording head according to claim 43, wherein a plurality of discrete piezoelectric thin films is provided on said diaphragm, and a plurality of separate electrodes is respectively provided on said discrete piezoelectric thin films,

wherein said diaphragm includes an insulating film, and

wherein portions of said common electrode that are not attached to said discrete piezoelectric thin film are thinner than portions of said common electrode that are attached to said discrete piezoelectric thin films.

48. (new): The ink jet recording head according to claim 43, wherein a plurality of discrete piezoelectric thin films is provided on said diaphragm, and a plurality of separate electrodes is respectively provided on said discrete piezoelectric thin films.

49. (Amended) The ink jet recording head according to claim 46, wherein a plurality of discrete piezoelectric thin films is provided on said diaphragm,
wherein said diaphragm includes an insulating film facing said ink chamber.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No. 10/606,182

Attorney Docket No. Q76316

50. (new): The ink jet recording head according to claim 49, wherein areas of said insulating film where said discrete piezoelectric thin films are not formed are thinner than areas of said insulating film where said discrete piezoelectric thin films are formed.

51. (new): The ink jet recording head according to claim 46, wherein a plurality of discrete piezoelectric thin films is provided on said diaphragm, and a plurality of separate electrodes is respectively provided on said discrete piezoelectric thin films.

52. (new): The ink jet recording head according to claim 43, wherein a plurality of discrete piezoelectric thin films is provided on said diaphragm, said common electrode is interposed between said discrete piezoelectric thin films and said diaphragm, and a plurality of separate electrodes is respectively provided on said discrete piezoelectric thin films.